RANGE MANAGEMENT RESEARCH AT FLAGSTAFF RESEARCH CENTER: ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Donald A. Jameson

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

RANGE MANAGEMENT RESEARCH

at

FLAGSTAFF RESEARCH CENTER

Rocky Mountain Forest and Range Experiment Station

(A Project Analysis and Working Plan)

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(A Project Analysis and Working Plan)

by

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PROJECT ANALYSIS

I. Scope

The geographic area considered in this project analysis is the southern half of the Colorado plateau including northern Arizona and the portions of the San Juan and Little Colorado River drainages in southwestern Colorado, northwestern New Mexico, and southeastern Utah. This area will be called the "Flagstaff area" in this paper. The specific localities to be considered are the areas that contain pinyon and juniper trees at present, and areas that offer distinct possibilities for the invasion of these species.

The project analysis will be further limited to problems directly related to production of forage for domestic and wild animals and to utilization of the forage. Related problems, including water production, recreation, and use of pinyon and juniper trees for timber or other products will be considered only as they relate to the problem of forage production and use.

II. Significance of the Type

The Timber Resource Review (U. S. Dept. Agr. 1933b) shows that there are 50,978,000 acres of noncommercial pinyon-juniper in the southern Rocky Mountain region. The preliminary tabulations for this review show that this total area includes 13,900,000 acres in Arizona, 13,875,000 acres in New Mexico, 3,857,000 acres in Colorado, 10,500,000 acres in Nevada, and 8,846,000 acres in Utah. In the United States as a whole there are 60,500,000 acres of noncommercial pinyon-juniper and only 850,000 acres of commercial forests[1] of these types.

1/ All in the northern Rocky Mountain region.

Many young invasion stands were probably not included in these acreage figures, and these figures certainly do not include the areas that are potential invasion sites for pinyon and juniper. The present and potential area of pinyon and juniper in the southern half of the Colorado plateau is probably in excess of 15,000,000 acres.

The primary use of the 50 million acres of pinyon-juniper in the southern Rocky Mountain region is forage production. Because of the size of the area water production is also a major consideration, even though water yield per acre is low. In general the type does not have as high a value for recreation as does the higher mountain area, but some sections are well known because of their striking topographic features. Many major highways run through the type and the travelers on those highways in general prefer woodland scenic areas to grassland.

At the present time commercial use of pinyon and juniper in the Flagstaff area is very limited (Arnold and Reid MS.). However, in Texas, Utah, and Nevada, juniper posts are being cut on a commercial scale. The trend of commercial interests toward utilization of lower-value trees indicates that much of the area may eventually be used for wood production. Arnold and Reid also point out the need for more intensive management of grasslands to meet increased future needs of beef production.

Additional information on the extent and nature of the pinyon-juniper woodlands can be found in problem analyses by Parker (1942),

Clendening (1948), and Arnold (1949). The descriptions of the pinyon-juniper type included in these earlier analyses will not be repeated here, but the general problems involved will be discussed as background information for presentation of specific problems.

III. General Problem

The most obvious and widespread problem in grazing-land management in the pinyon-juniper type is the presence of pinyon and juniper trees on sites that are well adapted to grass production, and a closely related problem is the possible future invasion of grassland by these trees. Invasion of areas that were once grass has greatly reduced forage production. Arnold and Schroeder (1953) have shown that 100 pinyon and juniper trees per acre may reduce forage production to 50 percent of that on areas without these trees, and a greater number of trees reduces forage production even further. There is the additional problem of very young trees, which are present in great number but which have not yet greatly influenced forage production, and there is the possibility that still more areas will be invaded in the future. In general the problem is to stop the invasion of pinyon and juniper, to convert desirable sites to productive grassland, and to manage the grassland for maximum practicable production.

Five tree species need to be considered in the pinyon-juniper type. These are pinyon (Pinus edulis Engelm.), Utah juniper (Juniperus osteosperma (Torr.) Little), one-seed juniper (J. monosperma (Engelm.) Sarg.), alligator juniper (J. deppeana Steud.), and Rocky Mountain juniper (J. scopulorum Sarg.).

Currently popular methods of control of juniper include cabling and pushing. Thousands of acres have been cleared by these methods but this is only a small percentage of the total area. Burning of individual trees and hand chopping have been practiced to a lesser extent. Use of fire on a broadcast basis has been very limited.

Development of techniques in cabling and pushing has progressed through the efforts of range technicians, ranchers, and equipment engineers, and these individuals will probably continue their efforts in this direction.

Development of burning procedures and tests of fire use to obtain maximum pinyon and juniper kill with minimum damage to desirable forage species is a need that should be emphasized by the Flagstaff Research Center. Such research will require the cooperation of ranchers and land-managing agencies to supply experimental areas and fire-control equipment.

Chemical and biological control methods for juniper have not yet been developed. The Agricultural Research Service is currently working on chemical control. The possible future value of these trees and related ornamental and commercial species should be considered in determining the desirability of biological control.

The general types of pinyon-juniper stands appropriate for control by cabling and pushing have been presented (U. S. Dept. Agr., Forest Service 1955a), and this information is general knowledge among many range technicians in the area.

In some dense stands the slash left after clearing is so excessive that there is little importance in available livestock feed. Burning after cabling has been suggested as one means of removing this excessive slash.

It should be possible to develop some general recommendations based on soil or vegetation present for selection of control areas. Price (1956) has stressed the importance of classifying sites to be controlled according to their potential as determined by ecological forces. Undesirable understory vegetation such as rabbit-brush (Chrysothamnus spp.), manzanita (Arctostaphylos spp.), oak (Quercus turbinella Greene and Q. Gambelii Nutt.), sagebrush (Artemisia tridentata Nutt.), mesquite (Prosopis juliflora (Swartz) DC.), and snake-weed (Gutierrezia Sarothrae (Pursh) Britt. & Rusby) decrease the probability of a successful clearing operation. Unless these species are also controlled, they will be benefited by juniper removal as much as the more desirable forage species. Oak brush, rabbit-brush, and mesquite present a particularly grave problem because of their sprouting properties.

The effect of clearing on desirable species must also be considered. Ponderosa pine (Pinus ponderosa Lawson) is of considerable importance in some of the area that contains juniper. Valuable shrubby species such as winter-fat (Eurotia lanata (Pursh), four-wing saltbush (Atriplex canescens (Pursh) Nutt.), and cliff-rose (Cowania mexicana D. Don), as well as forbs and grasses, must be considered.

The effect on these species will be particularly important in broadcast fire use.

The possibility exists that some juniper may be removed that has an economic use. Local use of juniper for fuel and fence posts was once important, but such use has declined rapidly in recent years with the lowered cost and greater convenience of other fuels and steel posts. There is some game use of juniper twigs when other feeds are scarce, especially in the case of alligator juniper. Although recreational and scenic use of the type is not as great as in some other areas, public interest has been demonstrated by complaints against juniper-eradication programs.

There is a great need for economic evaluation of juniper control. Costs vary greatly with terrain, soil, soil moisture, density of stand, and methods used. Benefits vary with site potential, vegetation present at time of control, and supplementary treatment and management following control.

Following control, grass or browse seeding is often desirable. The need for reseeding can arise from a lack of desirable vegetation before clearing, from destruction of the desirable vegetation by clearing, or from opening up of new areas for forage growth. Burning of down trees or other intense fire creates a situation that makes artificial and natural seeding difficult.

There has been little study on the proper grazing management of pinyon-juniper ranges. There is a need for information on management that will help control the situations and dispersal agents that lead

to the invasion of new areas and reinvasion of cleared areas. This will require a knowledge of reproduction, dispersal, establishment, and growth of the various species of pinyon and juniper.

There is also a need for information of the effect of grazing management on the desirable forage plants of the area. At present grazing in the pinyon-juniper type of Arizona is largely yearlong or winter-spring. There is some summer use, and in a few cases spring-fall use is practiced. These seasons of grazing need to be evaluated for their effects on vegetation and on grazing animals. Deferred rotation systems also need to be developed and tested for the area. Systems should be developed for ranches that must depend on pinyon-juniper type for the entire year and for seasonal use where other range is available for part of the year.

IV. Present Status of Information and Current Studies

A. Description, distribution, and behavior of individual species

The nomenclature for pinyon and juniper as presented by Kearney and Peebles (1951) will be used in this manuscript. The following discussion is taken largely from this source and from Sudworth (1915), Little (1950), and Preston (1942).

1. Pinyon (Pinus edulis Engelm.) is the most common pinyon pine in Colorado, Arizona, and New Mexico and is replaced by the related single-leaf pinyon (P. monophylla Torr. & Frem) in Nevada and western Utah. It is commonly called pinyon, Colorado pinyon, and nut pine. It most often occurs in mixed

stands with junipers but occasionally occurs in pure stands. This species has had some value for its nuts and has a potential value for its exudates (Beaver and Haskell 1935). In a burning program it is of particular interest because it is more inflammable than juniper.

2. Rocky Mountain juniper (Juniperus scopulorum Sarg.) is the least common of the juniper species in the problem area but ranges northward into British Columbia and has the largest distribution of any western juniper. In the problem area it occurs chiefly in the lower fringe of the ponderosa pine and in association with pinyon pine. This species is not considered to be a major problem within the Flagstaff area.

3. Alligator juniper (J. deppeana Steud.) is found in association with ponderosa pine in the transition pine stands, in extensive pure stands in central Arizona south of the Mogollon Rim, and in southern Arizona. It also extends into New Mexico, western Texas, and northern and central Mexico. It is the major species in the problem area south and west of Young described by Glendening (1948). This species is a particular problem because of its vigorous sprouting habit. Young trees will stump sprout from an area extending upward from the bottom of the butt swell. Six-year-old sprouts have been found that are 8 feet high and have a basal diameter of 1½ inches. This species is a silvicultural problem in the transitional ponderosa pine areas because of its rapid regrowth from sprouts following fire.

4. One-seed juniper (J. monosperma (Engelm.) Sarg.) is a common species between the ponderosa pine of the Mogollon Rim and the grassland areas adjacent to the Little Colorado River, the area north and east of Williams, and in other less extensive areas. It is the major species in the pinyon area described by Gleudening (1940) as being north of Heber. Its area of distribution includes Nevada, Utah, Colorado, New Mexico, western Texas, and northern Mexico.

5. Utah juniper (J. osteosperma (Torr.) Little) is the most widespread of the junipers in Arizona. It occurs over large areas of the Navajo and Hopi reservations (Beaver and Haskell 1933) and is also the most common species in much of the area west and southwest of Williams. It ranges into Idaho and Wyoming but is not found south of Arizona and New Mexico. The distinction between this species and J. monosperma is often difficult. J. osteosperma is described as being monoecious and one stemmed, while J. monosperma is dioecious and many stemmed. Individual trees have been found with several main stems, some of the stems bearing only female flowers and others bearing only male flowers. Single-sexed trees with central stems are common, as are monoecious trees with several main stems. These combinations of characters suggest that hybridization may be taking place or that there are actually several species in the group. Hall (1952) showed hybridization in the

genus is common. Van Melle (1953) found that J. scopulorum is occasionally monoecious, which suggests that J. monosperma may occasionally be monoecious.

B. Ecology and factors controlling distribution of the pinyon-juniper type

Cottam and Stewart (1940), working in Utah, found very old juniper trees along ridges and younger trees on lower slopes, which led them to conclude that the junipers are native in the West but that they are spreading from their original locations into new areas. This conclusion has been supported by comparison of old pictures with present-day juniper stands. These authors proposed that the rocky ridges that originally supported juniper are dry sites and that overgrazing has desiccated the grasslands and allowed invasion of juniper, and this conclusion has been supported by Parker (1945). Grazing has undoubtedly removed many of the original cool-season grasses, which probably compete more directly with juniper seedlings than do the warm-season grasses that now make up most of the grass cover. Range study plots in Arizona have shown that one-seed juniper and pinyon increased by a greater percentage on areas protected from grazing for 15 years than they did on grazed areas. Utah and alligator junipers, on the other hand, had a greater percentage increase in grazed areas (Arnold and Reid MS.). Woodbury(1947) suggested that local variations in distribution of juniper are caused by modifications of the moisture regime.

The evidence in general suggests that increased moisture resulting from reduction of grass competition by grazing favors establishment of juniper, but once established the trees grow best on areas that have the greatest infiltration capacity.

Some other papers on ecology of the pinyon-juniper region are by Merkle (1952) and Woodin and Lindsey (1954). These papers include descriptions of the vegetation present at Grand Canyon and east of the Continental Divide, respectively.

Fire is often considered as a limiting factor in the distribution of junipers in the days prior to organized fire control. (Humphrey 1953, 1953a, 1953b, and Emerson 1931) However, alligator juniper, which sprouts readily following top-killing fire, has also increased greatly according to early photographs, which indicates that fire certainly is not the only factor.

Birds and mammals have been credited with much of the spread of juniper. Phillips (1910) observed that juniper seeds were disseminated by birds, and Emerson (1932) specifically named jays as the most common agent. Miller (1931) observed that birds carried seeds of one-seed juniper, while sheep carried seeds of Utah juniper. Miller found several germinated seeds of Utah juniper with the seed still enclosed in sheep pellets. Emerson (1932) said that rodents were chiefly responsible for dissemination of pinyon nuts. Robinson (1956) observed whole juniper seeds in the feces of sheep, packrats, and jackrabbits,

and seeds have also been found in coyote feces. Scarification of juniper seeds improves germination (U. S. Dept. Agr. 1948) and it is possible that scarification occurs in the digestive tracts of animals when the seeds are consumed. Some rodents clip fruit and seed coat and remove the endosperm and embryo. During this process many seeds are clipped but uneaten, resulting in mechanical scarification (Robinson 1956).

There is considerable information from which the history of the spread of junipers can be gleaned. Humphrey and Bransomb of the University of Arizona are currently studying historical records and the first publication resulting from this study is expected to be available in the near future. While the conclusions reached from such a study may be subject to criticism, these workers probably will have made a comprehensive review of the material available.

Thomas H. Johnsen, Jr., of the Agricultural Research Service is currently studying the reproduction, establishment, and seedling growth of Utah and one-seed junipers as a basis for his doctorate thesis. This study should yield much information of the conditions necessary for establishment of these species.

The Soil Conservation Service is developing and using site classifications based on vegetation-soils complexes on the private lands within the Soil Conservation districts, including the pinyon-juniper type. The system used in this classification has been described by Dyksterhuis (1949)

C. Juniper control

1. Typical problems

Each individual area requires an individual evaluation to determine the method that should be used for juniper control (U. S. Dept. Agr., Forest Service 1956a). Cabling is used to best advantage in stands that contain very few small trees, as the smaller trees are flexible and are not killed by cabling. Cabling is also restricted to relatively rock-free areas. Pushing with bulldozers is applicable to a wider range of conditions. Although the initial cost of pushing is usually 2 to 3 times the cost of cabling, the long-time costs may be in favor of pushing because better control is obtained. Alligator juniper is very brittle and is more difficult to push than the other species because it is easily broken.

Hand chopping and sawing are adapted to very light stands of juniper. The use of hand chopping in young invading stands as a maintenance measure should be considered.

The slash left after cabling or pushing has received considerable attention. A cooperative study with the Coconino National Forest has been under way since 1955 to determine the possibilities of burning this slash with hopes of also killing the remaining small

trees. An attempt to reseed the areas where brush had burned was unsuccessful.

Some older burns observed indicate that grass-seedling establishment is very difficult for 4 to 5 years or more following burning of juniper. Some explanations that have been suggested are: (1) destruction of essential soil properties such as aggregation and organic-matter content, (2) production of a severe microclimate, and (3) liberation of some material in excess amounts as a result of burning. In a burned area near Young, curly-mesquite (Hilaria Belangeri (Steud.) Nash) invaded burned areas fairly rapidly by stolons. A preliminary greenhouse test has indicated that germination is not inhibited in these burned soils and that seedling growth is favored. A loss of structure and a marked decrease in infiltration rates of the burned soils have been observed. Preliminary chemical analyses have suggested that the burned soils are higher in total soluble salts, available phosphorous, sodium, and total nitrogen than are unburned soils.

The use of fire as a primary control measure has received considerable attention. Fire use has been tried in the following situations:

a. Broadcast burning in dense stands.

b. Broadcast burning in scattered stands, using grass fuel to carry the fire from tree to tree.

c. Burning of individual trees.

Each of the above situations involves a different approach, but in each case the objective of maximum pinyon and juniper kill with least damage to desirable plants is the same.

The Mescalero Indian Reservation and the Prescott National Forest have used broadcast burning in mature stands. The Mescalero Indians' first experience with this type of burning was with a wildfire of 25,000 acres in 1953. Since that time they have tried some intentional burning. Their results indicate that stands of 500 or more trees per acre will burn completely, stands of 300 to 500 trees per acre will give spotted burns, and stands of less than 300 trees per acre will not carry a fire. The amount of pinyon present seems to be an important factor in determining inflammability of a stand. Results from the Prescott National Forest also indicate the need for pinyon to carry a fire, although some old burns in nearly pure juniper stands have been observed.

Use of broadcast fire in light stands that have enough grass to carry fires has also been considered. The Coconino National Forest burned two areas on Deadman

Flat in January and March of 1956. There was a light northeast wind the time of the January burn and only partial kill of even the younger trees was obtained. The March burn had a stronger southwest wind and good kill was obtained on trees up to about 5 feet in height. On June 28, 1956, between 3 and 6 p.m., a wildfire occurred nearby in Wupatki National Monument, but grazing in the area has probably reduced the vigor of the grass plants and will therefore reduce the amount of information that might otherwise be obtained from this burn. Transects on these three burns indicate that there may be seasonal differences in the susceptibility of grass to damage by fire.

T. C. Bell burned the grass in a light stand of juniper west of Taylor, Arizona, in April 1955 and killed many trees up to 5 feet in height. Mr. Bell recommends burning with only enough wind to carry fire through the grass. The success of grass fires to kill junipers apparently depends on burning the accumulation of tumbleweeds and other herbaceous litter under the trees to scar the foliage of small branches of the junipers. High winds will blow the flames away from the upper parts of the trees. Probably better kill will be attained with low-crowding, bushy trees such as the many-stemmed

varieties of one-seed juniper than can be attained with upright trees because the bushy trees collect more litter.

A grass fire was used to kill young alligator junipers on the Fort Apache Indian Reservation in June 1952. There was considerable top kill, but by July 1953 the new sprouts had in most cases grown to the height of the dead stems. The Prescott National Forest experienced similar results in a June burn of a young stand of alligator juniper at Graver Wash (Pickett 1955).

Individual-tree burning has gained considerable favor among ranchers. Two types of equipment seem to offer promise: (1) Butane torches and (2) hand pumps that produce a self-igniting stream of fuel oil or diesel oil. Some ranchers using such equipment prefer to burn during the spring or fall drought periods. D. W. Wingfield reported 100-percent kill on Utah juniper and 50-percent kill on alligator juniper by burning with oil in June. A rancher in Pleasant Valley reported good kill on alligator juniper by piling brush around the stumps and burning in winter. This rancher leaves a stump at least 5 feet high because he believes high stumps will not sprout as readily as low stumps. Burning brush around the bases of standing alligator juniper trees has also been used by the Apache Indians but with little

success. On the Squaw Peak study plots near Young this treatment resulted in about a 50-percent kill.

Fenner, Arnold, and Rusk (1955) in California have found that use of area ignition increases the range of susceptable burning conditions. In this process 25 to 100 percent of the brush is smashed with crawler-type tractors to provide dry fuel, which allows burning under less severe conditions than are required without smashing. Ignition is simultaneous at a number of points in the burning area, which allows the buildup of considerable heat to ignite the unsmashed brush. The resulting fire creates its own indraft from all sides and requires less effort to control than does a running fire. Similar techniques might be developed in juniper, using partial cabling or pushing to provide the necessary dry fuel, but the extra cost of the preparatory operations must of course be considered.

Seasonal fluctuations in fuel and weather conditions probably will be very important in burning to control juniper and pinyon. It is generally assumed that hot, dry weather such as occurs during June results in the easiest ignition of fuels, but careful consideration of all burning factors and of susceptibility of plants to fire damage suggests that June may not be the best

time to use fire. Hawley (1926), in discussing the theoretical consideration of fuel inflammability, pointed out that chemical composition and moisture content of the fuel are also important factors. Resins are particularly important because they produce about twice as much heat as a comparable weight of nonresinous wood. Moisture is important because any moisture present must be driven from the wood or raised to the ignition temperature of the fuel before ignition can occur.

Richards (1940) followed the seasonal trends of moisture content, calorific value, and crude fat content of 5 shrubs, 2 grasses, and 1 forb in northern Idaho. He pointed out that low moisture content and high calorific values of the fuels would increase inflammability and rate of fire spread. The calorific value of each sample was largely dependent on total amounts of crude fat and the nature of the crude-fat constituents. Richards also suggested that the tenacity with which a plant holds its moisture may be an important consideration in determining the rate of fire spread.

Herman (1936) pointed out that growth of juniper trees starts in April or May, even in seasons when the summer rains do not start until late June. The onset of growth is probably preceded by a rise in moisture

content of the leaves and twigs and a corresponding decrease in inflammability of the trees. Because of the possible lower moisture content of the fuel during the winter months, it may be that a warm, dry winter or early-spring day will provide more satisfactory burning conditions than summer days.

Control of juniper by cabling, pushing, or burning provides new areas for forage-plant growth. In many cases reseeding to desirable forage species would be advantageous. Suggestions for reseeding can be found in publications by Lavin (1953), Reynolds, Lavin, and Springfield (1949), and Hull and Doran (1950). Lavin suggests that areas that receive less than 15 inches of precipitation annually should have some mechanical treatment to conserve soil moisture before reseeding is attempted.

2. Economic problems

For intelligent investment of funds in juniper-control work information is needed on the economic benefits of such control. The Production Economics Research Branch of the Agricultural Research Service has assigned Melvin Cotner, Tucson, to study the economic problems of pinyon-juniper ranges. Mr. Cotner contemplates a 3-year program to investigate the following subjects:

a. Determine expenses and total costs and appraise factors affecting costs of range-improvement practices for selected typical sites.

b. Evaluate the output resulting from range improvement and examine factors affecting quantity and value of output.

c. Determine the net returns from selected range improvements under specific range-management and site conditions.

d. For selected range sites, determine the returns needed to meet marginal costs of improvement practices.

e. Evaluate the effect of changes in price-cost relationships on profitability of range-improvement practices.

D. Grazing management

Grazing-management and clipping studies have been made on several of the important grass species that occur in the pinyon-juniper type, but these studies were not conducted within the type. Species studied included black grama (Bouteloua eriopoda Torr.) (Campbell and Crafts 1939, Canfield 1938, 1939a,b,c, and Nelson 1934), tobosa grass (Hilaria mutica (Buckl.) Benth.) (Canfield 1939c), blue grama (B. gracilis (H.B.K.) Lag.) (Long and Hernon 1942), and western wheat grass

(Agropyron Smithii Rydb.) (Lang and Barnes 1942). These studies and additional observations indicate that western wheat grass and black grama can be rather readily damaged by overgrazing, while blue grama and tobosa grass are much more resistant. Tobosa grass, in fact, requires frequent grazing to maintain it in a palatable condition, and little use of this species can be made in winter. Branson (1953) attributes the grazing susceptibility of western wheat grass to the elevated vegetative growing points of this species, and Nelson (1934) pointed out that grazing removed the stolons of black grama and stolons are the primary means of reproduction of this species. Galleta (H. Jamesii (Torr.) Benth.) and side-oats grama (B. curtipendula (Michx.) Torr.) are also common grasses in the region. Some less common grasses found in rolier areas of the type are green sprangle-top (Leptochloa dubia (H.B.K.) Nees.), bush muhly (Muhlenbergia Porteri Scribn.), and Texas-timothy (Lycurus phleoides H.B.K.). These last three species have been almost entirely eliminated from the type apparently by grazing.

Species such as black grama that are approaching the limits of their distribution in the pinyon-juniper type probably will require more careful management than they would in areas nearer the centers of their distribution.

Both winter- and summer-grazed allotments that have been observed in the pinyon-juniper region are generally in much

better condition than are allotments grazed year long. Winter use alone, as it does not remove active plant parts, is the least harmful. However, the usual grazing practice that falls under the name of winter use is actually late-fall, winter, and early-spring use. Repeated grazing during the early spring is very effective in destroying the cool-season grasses, which compete directly with juniper seedlings. A system of grazing that allows occasional rest during the spring growing season would help in maintaining the cool-season grasses, but even very careful management probably would not be effective in reestablishing these grasses.

Semideferred grazing and conservative stocking allowed improvement of black grama ranges at elevations lower than the pinyon-juniper type as shown in a series of papers by Canfield (1939, 1939a,b).

Utilization standards for black grama, blue grama, sideoats grama, western wheat grass, and tobosa grass have been presented by Campbell and Crafts (1938), Crafts (1938a,b,c), and Valentine (1938), respectively. However, utilization standards such as these are influenced by such a great number of variables that they are generally inadequate (Stoddard and Smith 1955).

Rhoes (1954) found that several areas in the ashe juniper woodlands of Texas returned to juniper regardless of grazing

treatment, but that proper utilization maintained desirable forage on the areas longer than overutilization. In the same areas Waldrip (1934) found that burned areas must be rested from grazing for at least 1 year following burning to provide adequate recovery of the forage species. Burning without adequate rest will undoubtedly result in severe depletion of the range.

V. Discussion of Specific Problems

A. Noxious-plant control

Noxious-plant control is the most apparent problem of the pinyon-juniper type. The presence of pinyon and juniper and other undesirable plants has reduced forage production far below the potential for the type.

1. Control methods

a. Mechanical methods

Mechanical methods of control of pinyon and juniper are in current use and there is general knowledge of the capabilities and limitations of these methods.

b. Chemical control

Development of methods of chemical control of noxious plants is the responsibility of the Agricultural Research Service. At present the A. R. S. is conducting research on chemical control of pinyon and juniper.

c. Use of fire as a control method

The basic problem of fire use is to provide maximum kill of the undesirable plants with minimum damage to the desirable plants, soil, and improvements. Research in fire use is urgently needed, not only to provide information that will allow control of pinyon and juniper, but also to determine if any of the suggested practices are likely to cause severe damage to the plant and soil resources. Some of the more basic questions to be answered are:

(1) What seasonal conditions of heat and desiccation resistance of the plants in question will allow prescribed burning to result in the best kill of pinyon and juniper with least damage to desirable plants?

(2) What are the seasonal changes in inflammability of tree foliage that are important in determining the best time for fire use?

(3) What are the seasonal weather conditions that are important in determining inflammability of fuels, ease of ignition, rate of fire spread, and hence the most effective use of fire?

Some questions on specific types of fire use under different seasonal and weather conditions are as follows:

(1) What density and composition of stand is required for successful crown fires?

(2) How much ground fuel is required to kill pinyon and juniper with a grass fire?

(3) What tree sizes can be killed with a grass fire?

(4) What equipment and techniques are desirable for individual tree burning?

(5) How can fire best be used as a means of removing trees killed by other methods? A study of removal of cabling slash by burning is currently in progress.

(6) What preliminary treatments will be required for application of the various ways of using fire? This question should be given a low priority unless a definite need for preliminary treatments is shown by further evidence.

(7) What preparation and precautions are necessary when using the various types of fires to reduce the risk of escapes? For the present time existing knowledge of fire-control procedures will probably suffice.

2. Response of vegetation and site to noxious-plant control

a. Mechanical and hand control

Response of vegetation to mechanical control of pinyon and juniper has received considerable attention in previous studies at this research center. It is not anticipated that these control methods will result in appreciable deterioration of the site. Probably some improvement will result.

b. Control by use of fire

Response of vegetation to fire use in the pinyon-juniper type has not been adequately evaluated, although some studies are in progress at the present time. More information is needed on the response of vegetation of different sites to the various types of fire use. Information is also needed on the influence of fire on the microclimate and physical, chemical, and microbiological properties of the different sites.

3. Economic evaluation of noxious-plant control

This problem is currently being studied by the Agricultural Research Service and no further work is being contemplated by the Flagstaff Research Center as long as the A. R. S. project is active. Some of the considerations in an economic study can be outlined as follows:

a. Costs

(1) Total cost of actual control operation.

(2) Cost of nonuse of land required as part of the control procedure.

(3) Cost of essential supplemental treatments.

(4) Cost of desirable but not absolutely necessary supplemental treatments.

(5) Cost of maintaining grass cover.

b. Damages

(1) Possible damage to site.

(2) Damage to existing forage.

(3) Possible damage to other uses.

(4) Damage to improvements.

c. Benefits

(1) Increased forage and livestock production.

(2) Possible improvement in site.

(3) Easier livestock handling.

(4) Possible benefits to other uses.

B. Ecology of the pinyon-juniper type

A clear understanding of the ecology of the type is essential for development of management systems that will develop and maintain maximum forage production and that will reduce invasion of noxious plants. Some of the specific questions are:

1. What are the important sites in the pinyon-juniper type, what vegetation is adapted to each site, and what are the potentials of each site? Recognition of the various sites will be required for refinement of research techniques and for application of research results by using agencies.

2. What are the phenological, growth-habit, and reproductive properties of the major desirable and undesirable species of the type that determine their ecological relationships? Such information is essential for evaluating, comparing, and developing grazing systems.

3. What is the ecology of relict areas? A better understanding of the type in its original condition should provide leads for its management and clues as to its biological potential.

4. Are there variations in the sprouting ability of alligator juniper that can be used to advantage in a control program?

5. What is the influence of climatic fluctuation on the forage production and species composition of the pinyon-juniper type? A direct attack on this question should be deferred until other more pressing questions have been answered. Some information will probably be obtained from studies designed to answer other questions.

6. What are the dispersal agents involved in the spread of juniper? Although this problem is of interest, preliminary

work indicates that many species of animals are involved in juniper-seed dispersal, and development of feasible methods of control of all the responsible agents is unlikely.

C. Grazing management

1. What is the grazing use of each important forage species in different mixtures, at different seasons, and under different management practices? Obviously, such information is needed in developing grazing systems.

2. What are the seasonal fluctuations in nutritive value provided by range species and how can deficiencies be corrected by supplementary feeding? Most nutritional studies have indicated that periods of high nutritive value of grasses are closely related to active growing periods. It can be assumed that the same trends apply in the pinyon-juniper type. While information on absolute nutritional levels will be needed for intensive herd management, practice has not yet reached this stage.

3. What species and methods for reseeding are applicable to the pinyon-juniper type? Research on these problems is the responsibility of the Agricultural Research Service.

4. What are the costs and benefits of range-management practices other than noxious-plant control? This problem is to be studied by the Agricultural Research Service in its current program. The problem will be reconsidered by the Flagstaff Research Center if the A. R. S. program is revised or terminated.

5. What grazing systems can be developed to meet seasonal grazing requirements, using only pinyon-juniper ranges and also using other types for part of the year? Studies of basic ecological and grazing-use problems are needed to provide background information for designing grazing systems. Tests of grazing systems could be undertaken on an experimental range or on cooperative demonstration allotments. Establishment of an experimental range would provide opportunities for precise control of livestock operations and for related grazing-management studies. Objectives of the current program should include securing an experimental range and establishing demonstration allotments in cooperation with land-management agencies and ranchers.

6. How can pinyon-juniper ranges be managed as wildlife habitat, and how can wildlife use be integrated with use by domestic stock? Mr. Bob Jantzen of the Arizona Fish and Game Commission will study the effect of juniper control on big-game animals as his master's-thesis problem at the University of Arizona. Range research at the Flagstaff Research Center will consider species that are important as game food when such species are present on study areas. The broader implications of the very important question of wildlife habitat have not been considered in this analysis.

D. Other uses of the pinyon-juniper type

1. Will juniper control reduce scenic and recreational values? Recreation areas and juniper-control areas can be kept apart by administrative action and no new fundamental knowledge should be required for proper decisions to be made.

2. Where should the line be drawn between timber production as the primary use and forage production as the primary use in the juniper-ponderosa pine transition zone? These transition zones are a minor part of the total area involved, and this problem would therefore be assigned a low priority from the range standpoint.

3. What is the effect of range-management practices on total water yield and sediment production? This problem falls within the problem of Watershed Management, and research is currently being started on this problem.

VI. Research Facilities Available

A. Personnel

The Flagstaff Research Center currently has finances for one full-time range-research position. One field assistant is usually hired for 3 months during the summer period. The Agricultural Research Service has assigned a man to the research center to study chemical control of juniper.

B. Equipment and operating allotments

The necessary equipment for most field studies is available or can be obtained within the current budgets. Only a limited amount of laboratory equipment could be obtained with the funds usually available.

C. Experimental ranges

No ranges for the primary use of range-research activities are presently established in the Flagstaff area. Study plots that do not require expensive nonrecoverable improvements can usually be established on lands administered by other government agencies. An experimental range is needed for intensive tests of grazing systems and other studies where complete control is required.

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WORKING PLAN

INTRODUCTION

The studies outlined in this section have been designed to meet the high-priority problems listed in the Project Analysis that can be included in the current program with the present research facilities. The program as outlined includes studies that will be started within 5 years. At the end of 5 years the overall program should be examined and revised as needed.

The program after this initial 5-year period should include the development and testing, on a pilot-plant scale, of intensive grazing systems. Hence an important part of the current program will be to locate an area for an experimental range in the pinyon-juniper type.

STUDY NO. 1

Use of Fire For Removing Excessive Debris Left After Cabling of Pinyon-Juniper

I. The Problem

Cabling of pinyon-juniper stands often leaves excessive debris that interferes with livestock movement and use of feed. Cabling also leaves many of the smaller trees, which increase in growth as a result of release from competition.

II. Objective

The objective of this study is to answer the following questions:

A. Can heavy debris be burned in place following cabling without inflicting excessive damage to forage production?

B. Are there any real differences in the amounts of fire damage when burning is done at different seasons?

C. Can fire-damaged areas be revegetated by reseeding?

D. To what degree will burning kill live trees left by cabling?

III. Present Information

Burning of cabling slash in the juniper type has been observed to result in bare areas for several years following burning.

IV. Methods

The plan for this study has been submitted and the study is already in progress. Slash was burned on duplicate plots at three different times of the year. One-half of each plot was reseeded. Ten 50-foot line transects were established on each subplot. These lines are to be rerun each year.

V. Cooperation

The Coconino National Forest cooperated on the original marking and will continue to cooperate in remeasurement of the transects.

VI. Establishment and Completion Dates

This study was established in 1965. It will be continued until 5 years of records are obtained and will then be reevaluated for continuation.

STUDY NO. 2

Seasonal and Diurnal Fluctuations in Moisture Content of Leaves and Twigs of Pinyon and Juniper

I. The Problem

Use of fire to control pinyon and juniper has been difficult to accomplish, partly because there is no concrete information on the fluctuation in inflammability of the trees to be burned.

II. Objective

To determine the seasonal and diurnal fluctuations in moisture content of pinyon and juniper foliage and small twigs, as a guide to inflammability.

III. Present Information

Much of the variation in inflammability is due to changes in moisture content. A knowledge of moisture changes should give information on changes in inflammability.

IV. Methods

Samples of pinyon, alligator juniper, one-seed juniper, and Utah juniper will be collected at 2-week intervals for 1 year and at hourly intervals through 1 day at several times during the year. Samples will be analyzed for moisture content.

V. Establishment and Completion Dates

This study will be begun as soon as the study plan is approved. It will continue for 1 year and will then be revised or terminated on the basis of the data obtained.

STUDY NO. 3

Seasonal Trends in Oil and Resin Content of Leaves and Twigs of Pinyon and Juniper

I. The Problem

The problem that necessitates this study is the same as for study No. 2.

II. Objective

To determine the seasonal trends in volatile oil and resin content of leaves and twigs of pinyon and juniper as a guide to inflammability.

III. Present Information

Resin and oil have a lower flash point than cellulose, and also produce more calories per gram when burned. About one-fifth of the total oil and resin content of pinyons and junipers is made up of volatile oils. The pinyon oils volatilize at about 180° C. The juniper oils volatilize between 260° C. and 290° C. If there are seasonal differences in the amounts of oils and resins, these differences should be important in determining inflammability differences, but there is no information available that indicates whether or not appreciable seasonal variations do occur.

IV. Methods

High cost of the required chemical analyses dictates holding the number of samples to a minimum, and the study will be preliminary in nature. Samples of leaves and twigs of pinyon and one-seed juniper will be collected at 6-week intervals for 1 year and analyzed for volatile oil and resin content. Alligator juniper will be omitted

from this preliminary study because fire use to control this species is not promising. Utah juniper will be omitted because it is expected that this species will have the same general seasonal trends as one-seed juniper. Oil and resin contents will be compared to time of sampling for use in predicting inflammability.

V. Cooperation

The Department of Agricultural Chemistry and Soils at the University of Arizona will conduct the required chemical analyses.

VI. Establishment and Completion Dates

This study will be established as soon as the study plan is approved. It will run for 1 year. Then it will be revised if this preliminary work reveals important changes in resin and oil content from season to season. If changes are unimportant, the study will be terminated.

STUDY NO. 4

Seasonal Trends in Heat and Desiccation Resistance of Major Trees and Grasses of the Pinyon-Juniper Type

I. The Problem

The goal of fire use is to obtain maximum kill of undesirable species with minimum damage to desirable species. If there are different seasonal trends in heat and desiccation resistance of the species involved, these differences can be used in planning fire use to reach the objective. A standardized method of determining relative heat and desiccation resistance will allow detection of seasonal differences.

II. Objective

To determine the seasonal trends in heat and desiccation resistance of major trees and grasses of the pinyon-juniper type, using a standardized heat treatment.

III. Present Information

Success of individual-tree burning and grass fires to kill junipers does not require that the trees actually ignite. Many trees can be killed by heat and desiccation without igniting. Survival of desirable plants depends in part on their heat and desiccation resistance. Seasonal variation in resistance can be determined by laboratory heat treatments.

IV. Methods

Samples of grass plants and twigs of pinyon and juniper will be collected at 4-week intervals. A standard method of heat treatment will be established, and the samples will be subjected to a range of standard heats to determine heat and desiccation resistance. After

treatments, viability of the tree tissues will be determined by a vital stain, and the live grass will be determined by attempting to revive the treated plants under greenhouse conditions.

V. Establishment and Completion Dates

This study will begin as soon as techniques are developed and study plan approved. The study will be conducted for 1 year and then will be revised or terminated after review of the findings.

STUDY NO. 5

Weather Factors Influencing Prescribed Burning in the Pinyon-Juniper Type

I. The Problem

Success in use of fire in the pinyon-juniper type has been erratic. Successful prescribed burning requires an understanding of the expected weather conditions that would influence the burning operation.

II. Objectives

To determine tentatively the limiting weather conditions for successful fire use in the pinyon-juniper type, including three general classes of fire use: burning of young trees in grass areas, burning out dense old tree stands, and individual-tree burning. To determine how often favorable burning conditions can be expected at different seasons.

III. Present Information

Information on use of fire in other vegetation types should provide clues as to weather conditions that may be desirable for successful burning in the pinyon-juniper type. Weather Bureau records and summaries are available to determine the occurrence of desired weather conditions.

IV. Methods

Limiting weather conditions will be tentatively determined by: (a) Adapting general principles of fire use from other types, (b) review of wildfire reports in the pinyon-juniper type, and (c)

discussions with fire experts. Probabilities of favorable conditions occurring at different seasons will be determined from Weather Bureau records.

V. Cooperation

The U. S. Weather Bureau and the University of Arizona are expected to provide weather records and will probably be able to give some help in compilation.

The Division of Fire Research will be expected to help guide the study.

VI. Establishment and Completion Dates

This study will probably be begun during 1957 and preliminary results should be available in 1958. Elaboration and refinement may be needed in later years.

STUDY NO. 6

The Influence of Grass Fires on Juniper and Some Major Grass Species of Northern Arizona

I. The Problem

Burning to control juniper often results in burning of grass as an unavoidable side effect or may require grass burning as an essential part of the operation. The effect of this burning on the grass species needs to be evaluated.

II. Objective

To evaluate the effect of burning under various conditions on survival and reestablishment of selected grass species.

III. Present Information

Observations of previous burns indicate that black grama, blue grama, and galleta grass survive winter burns fairly well, but are damaged severely by June burns.

IV. Methods

The variables to be considered will be stage of grass growth, species, soil moisture, fuel moisture, fuel weight, relative humidity, wind velocity, and temperature. General stage of grass growth and species will be the major independent variables. Although weather condition cannot be precisely controlled, burning will be done within prescribed limits and exact conditions will be measured at each burning date.

An area will be chosen for each species and a randomized-block design used. Approximate burning dates will be determined from the results of studies 2, 3, 4, and 5. The vegetation of each plot will

be sampled before burning and at yearly intervals after treatment. Tests will also be made to determine the influence of the fires on climate and soil conditions of the individual plots.

V. Cooperation

This study will probably be established on a national forest. The national forest involved is expected to construct necessary fire-breaks and be responsible for confining fires within prescribed areas.

VI. Establishment and Completion Dates

This study will be established after preliminary results from studies 2, 3, 4, and 5 are available, and will continue for about 5 years.

STUDY NO. 7

The Influence of Season and Burning Techniques on Individual-Tree Burning For Juniper Control

I. The Problem

Individual juniper trees can be killed at any time by burning with torches, provided that enough effort is used, but there is no information available on the best time to burn, nor has there been any valid comparison of burning techniques.

II. Objective

To determine the best season, methods, and weather conditions for burning individual pinyon and juniper trees.

III. Present Information

Popular methods of burning individual juniper trees include use of liquified petroleum torches or diesel oil torches, trimming and burning branches, and burning dead trees at the base of live trees. Most people who burn individual trees assume that the best time to do so is during seasonal drought periods in June or in the autumn.

IV. Methods

Seasons and weather conditions to be tested will be determined from the results of studies 2, 3, 4, and 5. At each treatment time 2 or 3 of the most promising types of equipment will be tested. Other variables to be considered are length of time that torches will be applied and comparison of crown flame vs. stem killing.

V. Cooperation

Ranchers, equipment dealers, and government agencies interested in individual-tree burning will be expected to furnish study areas,

equipment, and some labor for this study. The cooperating land-management agency will be responsible for adequate precautions to confine burning to the experimental area.

VI. Establishment and Completion Dates

This study will be established after preliminary results are available from studies 2, 3, 4, and 5. Treatments will extend through 1 year, or longer if necessary, and evaluations will continue for 2 or 3 years after treatments have been completed.

Influence of Seasonal and Weather Factors and Stand Characteristics on Control of Dense Pinyon-Juniper Stands by Mass Burning

I. The Problem

The use of crown fires in the pinyon-juniper type offers a possibility for rapid and cheap control of undesirable trees. At present very little information is available on the season or techniques that would be best for this type of fire, or on the classes of stands where such fire use may be feasible.

II. Objective

To determine the seasonal, weather, stand density, and stand composition factors influencing the success of prescribed crown fires for controlling pinyon and juniper.

III. Present Information

Crown fires in the pinyon-juniper type have been during the month of June. This is logical because of the seasonal mil and air moisture deficit at that time. Stands that have burned have had over 250 large-size trees per acre, and usually the stand composition has been about 40 percent pinyon and 60 percent juniper. Stands of less than 350 trees have burned only in spots. Stands of over 400 trees per acre have burned more completely.

IV. Methods

Land-management agencies have attempted a few crown fires during the past few years, and plan to continue such tests. The Flagstaff Research Center will assist and observe on the tests when occasions

permit. From the observations and from results of studies 2, 3, 4, and 5, refined specifications (season, weather, stand condition) will be developed and tested. Tests will be evaluated in terms of vegetation, local climate, and soil for a 10-year period following treatment.

V. Cooperation

The national forests are expected to provide study areas and fire-control equipment and personnel. No experimental burning will be done unless the national forest involved will assume the responsibility for containing the fire within the prescribed limits.

VI. Establishment and Completion Dates

This study will be established after the results of studies 2, 3, 4, and 5 are available. Evaluation of each fire included in this study will continue for about 10 years after the treatment date.

Study No. 9

Influence of Season of Cutting, Stump Height, and Tree Age on Sprouting of Alligator Juniper

I. The Problem

Alligator juniper sprouts readily after cutting, burning, and poisoning with some chemicals. This sprouting habit makes control very difficult. If there are conditions that limit the sprouting activity, knowledge of these conditions would aid in control of this species.

II. Objective

To determine the influence of season of cutting, stump height, tree age, and geographic location on sprouting of alligator juniper.

III. Present Information

Trees cut to a high stump are expected to have many small sprouts, while trees cut close to the ground are expected to have fewer, larger sprouts. Old trees are not expected to sprout to the same degree as young, vigorous trees. While these differences apparently apply to alligator juniper, specific details are needed for prescribing control methods. Furthermore, no information is available on seasonal and geographic location differences in sprouting ability.

IV. Methods

A. Season of cutting

Fifty maturing and vigorous alligator juniper trees will be cut to a 6-inch-high stump every other month for 1 year. After cutting, follow-up observations will be made to determine if the season of cutting had any influence on occurrence and amount of sprouting and on subsequent development of sprouts.

B. Stump height

During the summer months 50 trees will be cut to a 4-foot-high stump and the response of these trees will be compared to trees cut to 6 inches.

C. Age and condition of trees

During the summer months trees of various sizes and ages will be cut and the sprouting responses compared.

D. Location

Fifty trees of each of three or more geographic locations will be cut to determine if there are differences in sprouting ability between locations.

E. Interaction between factors

After the individual factors influencing sprouting have been investigated for 1 year, the possibility of investigating interactions between the factors will be considered.

V. Cooperation

National forests are expected to provide study areas and may furnish some assistance with the cutting.

VI. Establishment and Completion Dates

This study will be begun as soon as the study plan is approved. After the results of the first year's treatments are attained, the study will be terminated or revised and continued.

STUDY NO. 10

Identification and Classification of Important Sites of the Pinyon-Juniper Type

I. The Problem

Accurate identification and classification of sites is essential for determining which sites should have high priority for research work and for improvement projects, for reducing experimental error of research work, and for reliable extension of research results to other locations. No system of classification that meets these requirements is available for the pinyon-juniper type.

II. Objective

To develop a site-classification system for the pinyon-juniper type that will accomplish the following:

A. Help to establish priorities of work on different areas.

B. Allow more accurate experimental designs.

C. Allow extension of research results for use by land-management agencies.

III. Present Information

Several subdivisions of the pinyon-juniper type are now recognized. Some of these subdivisions are:

A. Climatic

Various parts of the type have been designated as warm-wet, warm-dry, cold-dry, cool-dry, etc.

B. Soil-parent material

The Soil Conservation Service is using a site-classification

system for part of the type based on soil-parent material, such as malpais, limestone, sand, cinders, and shale.

C. Topography and aspect

Some of the Soil Conservation Service sites are based on topography, such as hills, slopes, etc.

IV. Methods

A. Present methods of site classification in the type will be reviewed and other possible approaches will be explored. A tentative classification system will be outlined that is adequate from a research standpoint and that will include the present systems used by land-management agencies.

B. Range study plots and other field plots for which vegetation data are already available will be used for preliminary tests of the system developed in section A.

C. Using the information gained in sections A and B, the classification system will be revised and the revised system checked on a more extensive basis in the field.

V. Cooperation

Participation of the Station soils specialist will be essential.

Land-management agencies and research organizations interested in the pinyon-juniper type are expected to provide descriptions of their site-classification systems and will probably give some help in testing the system developed for the preliminary studies. Some of these agencies, such as the Soil Conservation Service and National Forest Administration, have yield and vegetation-composition information for many locations within the type.

VI. Establishment and Completion Dates

The preliminary work on this study will be begun in 1977. Preliminary results should be available within 2 years. Results of the study will not be final but will be subject to continuing revision as more information is available.

STUDY NO. 11

Autecology and Plant Competition in the Pinyon-Juniper Type of Arizona

I. The Problem

The increase of pinyon and juniper is evident throughout the type and in adjacent areas. Development of sound management practices to reduce this invasion and to increase forage production requires a clear understanding of the characteristics of the individual plant species, such as growth habits, seasonal developments, and reproduction, and of the relationships of these and their other characteristics.

II. Objective

To determine the ecological phenomenons that can be used to reduce reproduction of pinyon and juniper and to increase forage production in the type.

III. Present Information

Work conducted by Arnold at the Flagstaff Research Center has shown that pinyon and juniper trees reduce the density and production of grass present in the immediate vicinity. Removal of the trees allows an increase in grass production.

Thomas N. Johnsen is currently working on ecology of establishment of juniper seedlings for his Ph. D. dissertation at Duke University.

IV. Methods

Johnsen's results will be available in the summer of 1957. During 1957 some additional exploratory investigations will be begun,

including studies on soil moisture and plant phenology. Results of these preliminary studies will be considered along with Johnson's results, and the combined information will be used to prepare a detailed study plan for work beginning in 1958.

V. Cooperation

The Division of Watershed Management Research will cooperate in providing some soil-moisture data. Soil-moisture data collected at Walnut Canyon in a cooperative study with Dr. Waldo S. Glock can also be used in this study. The Coconino and Kaibab National Forests will provide experimental areas for the study.

VI. Establishment and Completion Dates

Preliminary studies will be begun in 1957. A detailed study plan will be prepared during the winter of 1957-58, and the work outlined by this plan will be begun in 1958. The study will continue for about 5 years.

STUDY NO. 12

Vegetation of Relict Areas in the Pinyon-Juniper Region

I. The Problem

Knowledge of the original vegetation conditions in the region would be very helpful in guiding many management practices and in determining the ultimate biological potential of the type. Relict areas offer a real opportunity to learn more about the original conditions.

II. Objective

To determine the plant composition of relict areas and to interpret the data for use in grazing management.

III. Present Information

Fish Tail Mesa on the Kaibab National Forest is a relict area of about 2 square miles. Part of the mesa has been burned and on the burned area big sagebrush is dominant. The mesa is definitely in the pinyon-juniper zone. There are additional relict areas in Grand Canyon, Zion, and Mesa Verde National Parks.

IV. Methods

Known relict areas will be surveyed and desirable areas will be selected for further study.

Permanent transects will be established on the areas for measurement of the vegetation at intervals of about 10 years. These transects will also serve as photopoints. Transects will be established on areas that show obvious differences, such as unburned and burned

areas. The number and size of the trees in a belt along the transects will be recorded, and ring counts of sample trees will be made. Observation of soil variation and animal life will be noted.

V. Cooperation

The Kaibab National Forest and the National Park Service are expected to help with the study. Possibility of air transportation will be investigated.

VI. Establishment and Completion Dates

This study will be established in the fall of 1957 and remeasurements will be made at about 10-year intervals.

STUDY NO. 13

Seasonal Utilization Patterns of Some Major Forage Grasses of the Pinyon-Juniper Type

I. The Problem

Management systems for rangelands require a knowledge of seasonal variation in utilization of the important forage species. Currently such information in the pinyon-juniper type is largely a matter of speculation.

II. Objective

To determine the seasonal utilization patterns of important grasses of the pinyon-juniper type to provide basic information for development of management systems.

III. Present Information

It is generally supposed that black grama and blue grama are preferred to other grass species for winter use by cattle. Species with a short growing season such as June grass are highly preferred for a few weeks each year. The available information is largely observational and should be clarified by research studies.

IV. Methods

In this study, qualitative data will be more important than quantitative, but some of the latter will be very helpful in developing grazing systems. Various methods of determining utilization, such as clipping, weight estimates, direct observation of livestock, will be reviewed and tried on a preliminary basis before methods are finally selected. Very likely exclosures in addition to those already available will be needed.

V. Cooperation

The land-managing agencies or ranchers on whose land the studies are established are expected to aid in construction of necessary enclosures and also to provide some assistance with the periodic sampling.

VI. Establishment and Completion Dates

It is expected that this study will be established by spring of 1938, and will continue for 3 or 5 years.